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Associations between adverse childhood experiences, attitudes towards COVID-19 restrictions and vaccine hesitancy: a cross-sectional study

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Title	Associations between adverse childhood experiences, attitudes towards COVID-19 restrictions and vaccine hesitancy: a cross-sectional study
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Abstract

Objectives: Adverse childhood experiences (ACEs) can affect life-course health and well-being, including risk-taking behaviour and trust. This study explored associations between ACEs and trust in health information on COVID-19, attitudes towards and compliance with COVID-19 restrictions, and vaccine hesitancy.

Design: National cross-sectional telephone survey using a sample of landline and mobile numbers stratified by Health Board, deprivation quintile and age group.

Setting: Households in Wales during national COVID-19 restrictions (December 2020 to March 2021).

Participants: 2,285 Welsh residents aged ≥18 years.

Measures: Nine ACEs; low trust in national health service (NHS) COVID-19 information; supporting removal of social distancing and mandatory face coverings, breaking COVID-19 restrictions, and vaccine hesitancy (rejection or uncertainty of vaccination).

Results: Increasing ACE counts were independently related to low trust in NHS COVID-19 information, feeling unfairly restricted by government and ending mandatory face coverings. High ACE counts (≥4 vs. 0 ACEs) were also associated with supporting removal of social distancing. Breaking COVID-19 restrictions increased with ACE count with likelihood doubling from no ACEs to ≥4 ACEs. Vaccine hesitancy was threefold higher with ≥4 ACEs (vs. 0 ACEs) and higher in younger age groups. Thus, modelled estimates of vaccine hesitancy ranged from 3.42% with no ACEs, aged ≥70 years, to 51.85% with ≥4 ACEs, aged 18-29 years.

Conclusions: ACEs are common across populations of many countries. Understanding how they impact trust in health advice and uptake of medical interventions could play a critical role in the continuing response to COVID-19 and controlling future pandemics. Individuals with ACEs suffer greater health risks throughout life and may also be excluded from interventions that reduce infection risks. Whilst pandemic responses should consider how best to reach those suffering from ACEs, longer term, better compliance with public health advice is another reason to invest in safe and secure childhoods for all children.

Article summary

Strengths and limitations of this study

- A large national sample surveyed during a period of national coronavirus restrictions.
- Although not unusual for unsolicited telephone surveys, the participation level was 36.4%, creating a potential for a self-selection bias among respondents.
- Prevalence of ACEs reported was consistent with other comparable population surveys, including those undertaken face to face.
- ACEs were self-reported and measured retrospectively and therefore may have been misremembered or otherwise misreported.
- Outcomes investigated both measures of trust and preference for different health regulations and restrictions as well as measures of behaviour.

INTRODUCTION

In many countries, the control of COVID-19 has relied on public acceptance of, and compliance with, restrictions on travel, work, socialising and public behaviour.[1] Medical advice provided through governmental and health professional bodies has formed the principal mechanism for encouraging social isolation, mask wearing and other COVID-19 prevention measures. Although restrictions are often reinforced with fines and other judicial measures, their implementation still depends heavily on public support.[2–4] Moreover, despite some discussion on mandatory vaccination, the success of this emergent COVID-19 control measure also relies on individuals having confidence in and complying with health messaging.[5] Consequently, it is critical for COVID-19 control to understand what factors differentiate individuals who may or may not trust health information, adhere to behavioural advice or accept offers of vaccination. Such understanding can inform the development and targeting of future measures to maximise behavioural compliance and vaccine uptake in different population groups.

Adverse childhood experiences (ACEs) include child maltreatment (physical, psychological, sexual and neglect) and other sources of chronic trauma in childhood, such as growing up in a household affected by domestic violence, substance use and other criminal justice problems.[6] Multiple studies have shown strong relationships between experiencing more types of ACEs and the development of health-harming behaviours such as smoking, harmful alcohol use and illicit drug use, as well as increased involvement in anti-social behaviour and violence.[7,8] Although suffering ACEs is not deterministic, higher exposure to ACEs is related to a greater likelihood of developing chronic health conditions such as cancer, cardiovascular disease, type 2 diabetes and respiratory diseases.[7,9–11] Thus, individuals with ACEs may be at greater risks of COVID-19 related morbidity and mortality through higher vulnerability resulting from behaviours such as smoking[12] and conditions such as obesity[13] and diabetes[14]. ACEs are also associated with substantive increases in poor mental health.[7,15] Moreover, more limited research suggests maltreatment during childhood may leave individuals with lower levels of trust including in health and other public services.[16,17] What is less well studied is whether a history of ACEs impacts compliance with advice and instruction from public health and health care systems. Around half of adults in Europe and North America have experienced at least one ACE with estimates suggesting around a quarter have suffered multiple ACEs.[18] Consequently, it is important to understand and address any impact of ACEs on compliance with COVID-19

controls in order to avoid repercussions both for the health of those with ACEs and for infection risks in surrounding communities.

Here, we examine relationships between a history of childhood adversity and current levels of trust in health systems information, support for and compliance with COVID-19 control restrictions, and intention to be COVID-19 vaccinated. We hypothesise that, independent of socio-demographics, exposure to more ACEs will be associated with less trust in health systems, lower support for governmental restrictions intended to control COVID-19 transmission and higher vaccination rejection rates (termed here vaccine hesitancy). We examine these relationships through a national anonymous telephone survey of adults in Wales. Finally, we explore how measures to influence public behaviour might better support those who have suffered ACEs with respect both to COVID-19 and preparing for other future pandemics.

METHODS

Data collection

A national telephone survey of Welsh residents aged 18 years and over was conducted between December 2020 and March 2021. All data collection occurred within a period of Welsh national COVID-19 restrictions, which limited social contact through social distancing, bans on household mixing, closure of non-essential retail and mandatory face covering use in indoor public places. A target sample of 2,000 was set to capture adequate individuals across ACE categories, with a minimum of 200 respondents in the highest ACEs category (4+).[17] A professional market research company (MRC) was commissioned to undertake sampling and data collection. Landline and mobile telephone contacts were obtained from a commercial sample provider stratified by Welsh Health Board area, residential deprivation quintile (using Welsh Index of Multiple Deprivation [WIMD][19]) and age group, to attain a sample broadly representative of the age, deprivation and geographical profile of the Welsh population.

Study inclusion criteria were Welsh resident aged 18 years or over and cognitive ability to participate in a telephone interview. Potential participants were given a verbal description of the study including its purpose and voluntary, anonymous and confidential nature. Participants were informed they could skip or decline questions, withdraw at any point and

that a decision to stop would not affect their rights, health treatment or service provision. Informed consent was recorded using opt-in consent. A web address was provided to participants containing further study information and links to appropriate support services. All study materials were provided in English and Welsh and participants could complete the interview in either language. Telephone calls were made across all days of the week; between the hours of 9am-9pm on weekdays and 10am-4pm on weekends, and interviews took on average 20 minutes to complete.

Contact was made with 6,763 individuals, of whom 98 (1.4%) were ineligible, 4,062 (60.1%) declined and 2,424, agreed to participate in the study. Of those who agreed, 277 did not meet the age quota in their area and 2,326 completed the questionnaire. Thus, the participation rate was 36.4% (2,326/6,388) of eligible individuals who met the quota sampling, or 34.9% (2,326/6,665) of all eligible participants. The sample used for analysis here was limited to participants who answered all questions of interest (N=2,285).

Study questionnaire

The study questionnaire included questions on participant demographics, ACEs, health conditions, trust in information on COVID-19 from the National Health Service (NHS), and attitudes towards COVID-19 restrictions and vaccination. All measures were self-reported. The full questions and response options used to measure ACEs and the outcomes included in this study are provided in Appendix Table A1.

Nine ACE types before the age of 18 years (physical, verbal and sexual abuse; parental separation; exposure to domestic violence; and living with a household member with mental illness, alcohol abuse, drug abuse or who was incarcerated) were measured using an adapted version of the Centers for Disease Control and Prevention short ACE tool.[20] In line with international literature, responses to the nine ACE questions were used to calculate an ACE count (0 ACEs, 1 ACE, 2-3 ACEs, 4+ ACEs). *Low trust in NHS COVID information* was measured by a question asking how much participants would trust information on COVID-19 from the NHS (scale 0=not at all, 10=completely; low <6). Feeling *unfairly restricted a lot by government* was identified by a response of 'yes, a lot' to a question asking if, during the pandemic, participants felt they had been unfairly controlled by the national restrictions imposed by the government. Beliefs that *mandatory face coverings should go* and *social distancing should end* were measured with questions asking if face coverings in shops should

continue to be a legal requirement (qualifying response 'no') and if social distancing should remain in place or be removed (qualifying response 'be removed') respectively. Participants were asked if, during lockdown or local COVID-19 restrictions, they had always followed the advice, bent or broken the rules occasionally, or largely ignored the rules; those providing either of the latter two responses were categorised as *break restrictions at least occasionally*. *Vaccine hesitancy* was identified by responses of 'no' or 'unsure' to a question asking if participants would want to receive a COVID-19 vaccination. Participants were categorised as having *had COVID-19* if they responded 'yes' to a question asking if they thought they have had, or currently have, coronavirus; and as having had a *chronic disease* if they reported having ever been told by a doctor or nurse that they had any of the following conditions: cancer, type 2 diabetes, heart disease (coronary heart disease, heart attack or stroke), or respiratory disease (chronic bronchitis, emphysema, chronic obstructive pulmonary disease, asthma).

Respondents' age (five year age groups), sex (male; female; other), ethnicity (self-defined using UK census categories) and postcode of residence were also collected. For the purposes of analysis age was categorised into ten year age groups (18-29; 30-39; 40-49; 50-59; 60-69; 70+) and due to low levels in non-white categories, ethnicity was re-categorised (white, other). Postcode was categorised into deprivation quintile by the MRC using the WIMD (1=least deprived to 5=most deprived).

Statistical analysis

Statistical analyses used SPSS v27. Cross-tabulations and chi-square tests were used to measure relationships between outcome variables, and to examine initial relationships between outcome variables and ACEs and other participant characteristics (age, sex, ethnicity, deprivation, COVID-19 infection and chronic disease). Independent associations between ACEs and outcomes were measured using logistic regression, controlling for other participant demographics. Having had COVID-19 was included in the model as it was hypothesised that individuals who report this may feel protected from the virus.[21] Similarly suffering from a chronic disease was included in the model as individuals with a chronic disease may feel more at risk of the virus. Finally, the estimated adjusted proportions (estimated marginal means; EMMs) reporting breaking restrictions at least occasionally and vaccine hesitancy in different ACE categories and age groups were generated from the final logistic regression models.

Patient and public involvement

The study did not involve patients. Study findings are being made publicly available to participants and the general public through the production of study reports and open access journal articles. The study webpages provided contact details for the research team if any individual wished to directly request publications.

RESULTS

Approximately half of participants reported having experienced no ACEs (51.86%) with proportions in the 1 ACE, 2-3 ACEs and 4+ ACE categories being 21.40%, 16.46% and 10.28% respectively. A breakdown of participant demographics by ACE count is shown in Appendix Table A2. Respondents' views of having low trust in NHS COVID-19 information and being unfairly restricted a lot by government were correlated with higher levels of favouring the immediate cessation of social distancing and mandatory face coverings, breaking restrictions, and vaccine hesitancy (Table 1).

Table 1. Relationships between views on fairness of restrictions, trust in NHS COVID-19 information and support for COVID-19 control and vaccination measures

		Low trust in NHS COVID-19 information (%)	Unfairly restricted a lot by government (%)	Social distancing should end (%)	Mandatory face coverings should go (%)	Break restrictions at least occasionally (%)	Vaccine hesitancy (%)
All (n=2,285)		5.82	9.41	5.91	5.82	25.86	7.75
Low trust in NHS COVID-19 information	No		7.81	4.51	4.32	24.86	5.62
	Yes		35.34	28.57	30.08	42.11	42.11
	X^2		111.387	130.480	151.552	19.426	233.296
	P		<0.001	<0.001	<0.001	<0.001	<0.001
Unfairly restricted a lot by government	No	4.15		3.91	3.77	24.40	5.80
	Yes	21.86		25.12	25.58	40.00	26.51
	X^2	111.387		157.517	169.061	24.732	116.950
	P	<0.001		<0.001	<0.001	<0.001	<0.001

NHS = National Health Service. See Appendix Table A1 for full wording of all questions and classification of responses.

Low trust in NHS COVID-19 information

Individuals with higher ACE counts were more likely to have low trust in NHS COVID-19 information along with individuals from more deprived quintiles of residence (Table 2). Other socio-demographics and a history of either chronic disease or COVID-19 infection were not significantly associated with low trust. When using logistic regression to control for confounding relationships, ACEs and deprivation were the only significant predictors of trust in NHS COVID-19 information (Table 3).

Unfairly restricted a lot by government

Just under one in 10 people reported feeling unfairly restricted (Table 1). This rose with ACE count, with the proportion among those with four or more ACEs being more than twice as high as in those with none (Table 2). Younger individuals were also more likely to report feeling unfairly restricted, along with those who were resident in more deprived quintiles and those who reported having had COVID-19 (Table 2). When using logistic regression, independent relationships between feeling unfairly restricted and increasing ACE count remained, although differences between the no ACE and one ACE categories failed to reach significance. Logistic regression showed younger age and being male were also significantly related to feeling unfairly restricted (Table 3).

Social distancing should end

Supporting the removal of social distancing increased more than threefold from those with no ACEs to those with four or more (Table 2). Ending social distancing was also significantly more supported by those who were younger and male. Ethnicity, deprivation, or having had COVID-19 or a chronic disease were not significantly associated with support for ending social distancing. Using logistic regression, having more ACEs was still significantly associated with favouring ending social distancing but only having four or more ACEs remained significantly different from no ACEs (Table 3). Those aged 60 years or over were significantly less likely to support ending social distancing (compared with those aged 18-29 years) with males also substantially more likely than females to support social distancing ending (Table 3).

Table 2. Adverse childhood experiences, socio-demographics, other individual characteristics and associations with compliance with, trust in and support for COVID-19 control measures

		n	Low trust in NHS COVID-19 information (%)	Unfairly restricted a lot by government (%)	Social distancing should end (%)	Mandatory face coverings should go (%)	Break restrictions at least occasionally (%)	Vaccine hesitancy (%)
ACE count	0	1,185	4.05	7.26	4.39	3.46	20.93	4.98
	1	489	5.73	8.59	5.73	6.34	28.02	7.16
	2-3	376	7.45	12.23	5.59	7.45	31.12	10.11
	4+	235	12.34	17.45	14.47	14.04	37.87	19.15
	X^2		26.817	28.154	35.999	43.081	39.321	58.625
	P		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Age (years)	18-29	174	6.90	16.09	10.92	9.77	47.70	18.39
	30-39	239	7.11	12.97	9.21	12.97	35.98	15.90
	40-49	371	6.20	10.78	9.16	8.89	28.84	9.16
	50-59	543	5.16	9.21	6.45	5.16	26.34	7.00
	60-69	447	4.70	7.83	3.13	3.36	23.04	4.70
	70+	511	6.26	6.07	2.15	1.76	13.50	2.74
	X^2		2.839	21.525	39.054	54.389	100.389	75.027
	P		0.725	0.001	<0.001	<0.001	<0.001	<0.001
Deprivation quintile	Least 1	495	4.44	9.29	4.65	4.24	26.67	4.44
	2	509	3.73	5.70	4.13	4.32	26.13	5.50
	3	490	5.10	8.16	6.33	5.51	28.37	7.76
	4	437	8.70	11.67	7.55	6.86	25.63	9.84
	Most 5	354	8.19	13.84	7.63	9.32	21.19	12.99
	X^2		16.440	19.909	8.485	13.207	5.838	27.466
	P		0.002	0.001	0.075	0.010	0.212	<0.001
Sex	Male	806	6.95	10.67	7.69	8.06	27.79	8.56
	Female	1479	5.21	8.72	4.94	4.60	24.81	7.30
	X^2		2.887	2.322	7.131	11.438	2.412	1.156
	P		0.089	0.128	0.008	0.001	0.120	0.282
Ethnicity	White	2,254	5.77	9.36	5.90	5.81	25.87	7.59
	Other	31	9.68	12.90	6.45	6.45	25.81	19.35
	X^2		0.853	0.450	0.017	0.023	0.000	5.926
	P		0.356	0.502	0.897	0.880	0.994	0.015
Had COVID-19[$]	No	1,837	5.50	8.49	5.50	5.39	24.39	6.80
	Yes	448	7.14	13.17	7.59	7.59	31.92	11.61
	X^2		1.777	9.245	2.833	3.180	10.656	11.625
	P		0.182	0.002	0.092	0.075	0.001	0.001
Chronic disease[£]	No	1,488	5.51	9.68	6.45	7.06	29.50	8.40
	Yes	797	6.40	8.91	4.89	3.51	19.07	6.52
	X^2		0.747	0.360	2.267	11.887	29.452	2.556

P	0.387	0.548	0.132	0.001	<0.001	0.110

ACE = adverse childhood experience. [$]Having had COVID-19 was self-reported, see methods. [£]Chronic diseases included cancer, type II diabetes, heart disease and respiratory diseases, see methods for details. Full wording of all questions is provided in Appendix Table A1.

Table 3. Logistic regression analysis of relationships between adverse childhood experiences (ACEs), socio-demographics and other individual characteristics and compliance with, trust in and support for COVID-19 control measures

		Low trust in NHS COVID-19 information			Unfairly restricted a lot by government			Social distancing should end			Mandatory face coverings should go			Break restrictions at least occasionally			Vaccine hesitancy		
		AOR	95%CIs	P	AOR	95%CIs	P	AOR	95%CIs	P	AOR	95%CIs	P	AOR	95%CIs	P	AOR	95%CIs	P
ACE count	0	Ref		<0.001	Ref		0.002	Ref		<0.001	Ref		<0.001	Ref		<0.001	Ref		<0.001
	1	1.46	0.90-2.37	0.123	1.13	0.76-1.67	0.549	1.22	0.76-1.98	0.410	1.80	1.10-2.94	0.019	1.34	1.05-1.73	0.020	1.29	0.83-2.02	0.254
	2-3	1.82	1.11-2.99	0.017	1.50	1.02-2.21	0.042	1.01	0.60-1.72	0.963	1.76	1.06-2.93	0.029	1.48	1.13-1.94	0.004	1.56	1.01-2.43	0.047
	4+	3.22	1.94-5.36	<0.001	2.19	1.44-3.33	<0.001	2.89	1.79-4.68	<0.001	3.57	2.14-5.94	<0.001	2.01	1.47-2.76	<0.001	3.11	2.00-4.82	<0.001
Age (years)	18-29	Ref		0.819	Ref		0.112	Ref		<0.001	Ref		<0.001	Ref		<0.001	Ref		<0.001
	30-39	1.05	0.48-2.30	0.897	0.78	0.44-1.37	0.378	0.88	0.45-1.71	0.706	1.51	0.79-2.88	0.214	0.66	0.44-0.98	0.041	0.82	0.48-1.40	0.465
	40-49	1.08	0.52-2.24	0.847	0.71	0.41-1.20	0.198	0.96	0.52-1.77	0.900	1.13	0.60-2.14	0.702	0.49	0.34-0.72	<0.001	0.51	0.30-0.88	0.015
	50-59	0.92	0.45-1.88	0.819	0.63	0.38-1.05	0.074	0.67	0.37-1.23	0.197	0.67	0.35-1.27	0.219	0.44	0.31-0.63	<0.001	0.41	0.24-0.69	0.001
	60-69	0.89	0.42-1.89	0.753	0.55	0.32-0.96	0.034	0.32	0.15-0.66	0.002	0.46	0.22-0.96	0.038	0.38	0.26-0.56	<0.001	0.29	0.16-0.53	<0.001
	70+	1.29	0.62-2.69	0.495	0.45	0.25-0.79	0.006	0.23	0.10-0.50	<0.001	0.27	0.11-0.64	0.003	0.22	0.15-0.34	<0.001	0.18	0.09-0.36	<0.001
Deprivation quintile	Least 1	Ref		0.024	Ref		0.012	Ref		0.275	Ref		0.157	Ref		0.031	Ref		0.010
	2	0.82	0.43-1.53	0.527	0.59	0.36-0.96	0.034	0.87	0.47-1.61	0.664	1.04	0.56-1.94	0.903	1.01	0.75-1.34	0.970	1.30	0.73-2.34	0.375
	3	1.14	0.63-2.06	0.666	0.84	0.54-1.32	0.451	1.36	0.77-2.39	0.285	1.28	0.71-2.34	0.413	1.07	0.80-1.43	0.631	1.76	1.01-3.05	0.046
	4	1.87	1.08-3.24	0.026	1.19	0.77-1.82	0.433	1.54	0.88-2.71	0.131	1.56	0.86-2.81	0.143	0.89	0.66-1.21	0.468	2.09	1.21-3.61	0.008
	Most 5	1.64	0.91-2.95	0.100	1.33	0.85-2.07	0.209	1.36	0.75-2.46	0.318	1.91	1.06-3.45	0.033	0.64	0.45-0.89	0.009	2.44	1.41-4.23	0.001
Sex*	Male	1.42	0.99-2.04	0.059	1.35	1.01-1.82	0.044	1.89	1.32-2.72	0.001	2.29	1.59-3.31	<0.001	1.28	1.05-1.57	0.016	1.37	0.99-1.91	0.060
Ethnicity*	Other	1.44	0.42-4.93	0.559	1.00	0.34-2.94	1.000	0.70	0.16-3.00	0.626	0.63	0.14-2.73	0.534	0.70	0.30-1.61	0.395	1.78	0.69-4.56	0.230
Had COVID-19*,$	Yes	1.18	0.77-1.81	0.443	1.37	0.99-1.91	0.058	1.07	0.71-1.63	0.745	1.04	0.66-1.55	0.949	1.22	0.96-1.54	0.104	1.33	0.93-1.90	0.121
Chronic disease*,£	Yes	1.07	0.73-1.58	0.722	0.99	0.72-1.36	0.958	0.92	0.61-1.38	0.691	0.55	0.35-0.87	0.010	0.68	0.54-0.85	0.001	0.94	0.65-1.35	0.731

AOR = adjusted odds ratio; 95%CIs = 95% confidence intervals; Ref = reference category. $Having had COVID-19 was self-reported, see methods. £Chronic diseases included cancer, type II diabetes, heart disease and respiratory diseases, see methods for details. *Reference categories for sex, ethnicity, Had COVID-10 and chronic disease were female, white, not had COVID-19 and not had a chronic disease respectively. Full wording of all questions is provided in Appendix Table A1.

Mandatory face coverings should go

Support for ending mandatory face coverings increased more than fourfold between those with no ACEs and those with four or more ACEs (Table 2). Younger individuals, those resident in more deprived quintiles, males and those who had not had a chronic disease were more likely to support mandatory face coverings ending. In logistic regression, ACE counts continued to show a positive relationship with support for ending mandatory face coverings. This was significant even with a single ACE compared to those with no ACEs (Table 3). Younger ages, being male and not having had a chronic disease remained significantly associated with ending mandatory face-covering measures. However, differences by age were only significant between the 18-29 years and 60+ years groups (Table 3).

Break restrictions at least occasionally

Overall, around one in four respondents broke COVID-19 restrictions at least occasionally (Table 1). In bivariate analyses, proportions having broken restrictions increased with increasing ACE count and decreased with age but were not significantly related to deprivation, sex or ethnicity. Those who reported having already had COVID-19 and those without a history of chronic disease were more likely to have broken restrictions (Table 2). When controlling for relationships between variables, breaking restrictions remained strongly related to ACE count with the likelihood of such behaviours being twice as high in those with four or more ACEs compared to those with none (Table 3). Breaking restrictions also remained significantly associated with younger ages and not having suffered from a chronic disease, with deprivation also marginally significant (with less restriction breaking in the most deprived quintile; Table 3).

Vaccine hesitancy

Around one in 13 individuals surveyed reported vaccine hesitancy (Table 1). However, this increased around fourfold between those with no ACEs and those with four or more (Table 2). Younger age groups were also more likely to report vaccine hesitancy along with those living in more deprived quintiles, those of other than white ethnicity and those who had already had COVID-19 (Table 2). Applying logistic regression, having more ACEs remained significantly associated with vaccine hesitancy, although the difference between the no ACEs and one ACE category was not significant. Younger age remained strongly related to vaccine

hesitancy along with being resident in more deprived quintiles. Ethnicity was not related to vaccine hesitancy once ACEs, age and deprivation had been accounted for (Table 3).

For breaking restrictions and vaccine hesitancy we also generated estimated levels (EMMs) in order to provide absolute measures of prevalence of breaking restrictions and vaccine hesitancy by ACE and age categories (Figures 1 & 2). For having broken restrictions at least occasionally, estimated levels ranged from 10.67% (95% confidence intervals [95%CIs], 6.72%-16.53%) in those aged 70+ years with no ACEs to 51.95% (95%CIs 38.34%-65.27%) in those aged 18-29 years with four or more ACEs (Figure 1). Similarly for vaccine hesitancy, levels ranged from 3.42% (95%CIs 1.66%-6.93%, no ACEs, aged 70+ years) to 38.06% (95%CIs 24.08%-54.35%, 4+ ACEs, aged 18-29 years; Figure 2). Within any single age group, ACE count contributed to a steep increase in predicted breaking of restrictions and vaccine hesitancy. For instance, for vaccine hesitancy, in those aged 30-39 years, there was a rise from 13.95% (95%CIs 7.83%-23.62%) in those with no ACEs to 33.48% (95%CIs 20.75%-49.18%) in those with four or more (Figure 2). Confidence intervals for all data points are provided in Appendix Table A3.

Figure 1 Adjusted mean percentage of individuals having broken COVID-19 restrictions at least occasionally, by age and adverse childhood experience (ACE) count

Figure 2 Adjusted mean percentage of individuals with vaccine hesitancy, by age and adverse childhood experience (ACE) count

(Insert Figures 1 and 2 here)

DISCUSSION

Voluntary compliance with public health advice has played a central role in reducing the viral transmission of COVID-19. In this study, approximately a quarter of participants admitted to at least occasionally breaking the rules (Table 1) while a minority supported immediately ending social distancing and face coverings (5.91% and 5.82% respectively; Table 1); regulations in place at the time of this study.[22] Critically, 7.75% of individuals would not immediately agree to a COVID-19 vaccination. Vaccine hesitancy, as well as breaking or ending current restrictions, were related to socio-demographics with younger age groups in particular reporting more restriction breaking and higher vaccine hesitancy (Table 2 &

Figures 1 & 2). As reported elsewhere, males were also more likely to break restrictions and favour an end to those in place (Table 3).[3,23] Lower trust in NHS COVID-19 information and feeling unfairly restricted by government were also related to vaccine hesitancy and restriction breaking (Table 1). However, whilst interrelations between trust in public bodies and compliance with guidance has been studied elsewhere,[2,24] far less attention has paid to the life-course factors that may contribute to lower trust in health and state systems and potential rejection of related regulations and medical interventions.

Critically, most individuals surveyed, including those with ACEs, supported and followed COVID-19 restrictions (Table 2, Figure 1). However, results identify individuals with a history of childhood adversity having less trust in NHS COVID-19 information and being more likely to favour removal of control measures (Tables 2 and 3). Lower trust in NHS COVID-19 information tripled between those with no ACEs and those with four or more and feeling unfairly restricted by government more than doubled (Table 2). Such increases are consistent with other findings here that individuals with four or more ACEs were two times more likely to break restrictions at least occasionally compared to those with no ACEs when controlling for relationships with socio-demographic factors and history of COVID-19 infection or chronic disease (Table 3). Studies elsewhere suggest individuals with ACEs are more likely to have developmental and behavioural factors that increase the risk of ill health across the life-course;[25] potentially leaving them more susceptible to infection and ill health from COVID-19 (e.g. through smoking, cancer[7,12,26]). Consequently, understanding why individuals with ACEs may be more likely to reject virus control measures is vital to protecting their health.

A number of outcomes previously associated with exposure to ACEs may contribute to links between greater ACE exposure and lower compliance with and support for COVID-19 interventions. Higher ACEs are associated with lower acceptance of delayed gratification with greater preference for short term returns at the expense of potentially greater return in the longer term.[27,28] ACEs have also been associated with lower prosocial behaviours and sense of belonging,[17,29] although such effects are not well studied in adults, nor whether they affect consideration of how personal behaviour may impact the well-being of others in local communities. However, a history of ACEs is known to be associated with other anti-social behaviours, including violence.[7] Higher exposure to ACEs is also associated with poorer mental well-being and alcohol and drug use[18] with the latter especially having

known associations with the adoption of wider risk-related behaviours.[30,31] Finally, ACEs have been associated with having lower trust both in other individuals and public services,[16,17,32] a finding consistent with results here whereby lower trust in COVID-19 information from the NHS increased from 4.05% with no ACE to 12.34% in those with four or more (Table 2).

With vaccination at the centre of COVID-19 control strategies going forward, higher levels of vaccine hesitancy in those with more ACEs is an important consideration. In those aged 18-29 years, modelled vaccine hesitancy more than doubled from an estimated 16.52% in those with no ACEs to 38.06% in those with four or more (Figure 1, Appendix Table A3). In this study 48.14% of individuals had at least one ACE and 10.28% had four or more. Such figures are consistent with those reported in other studies (e.g. England,[33] USA,[9] New Zealand[34]) suggesting that ACEs are a feature of the life-course of a substantive proportion of the population. Consequently, unaddressed high levels of vaccine hesitancy in this group represent a significant risk to the health of those with a history of ACEs and potentially also to those in surrounding communities. Our results suggest that ACE- and trauma-informed approaches may be an important consideration when considering compliance with infection control restrictions and in improving uptake of medical interventions such as COVID-19 vaccination. Although little work has been undertaken specific to COVID-19, increased compliance from those with ACEs may benefit from a greater emphasis on safety and trustworthiness. Thus, strategies may consider use of alternative spaces and settings, avoiding ones which may potentially be associated with previous negative experiences for some individuals (e.g. health care). They may also require different channels for information provision to account for lower trust in public services. Moreover, awareness and training for those contacting individuals, potentially with a history of trauma, may allow them to support those still wavering, for instance, with vaccine compliance.[35]

Consistent with exposure to ACEs not being deterministic of outcomes such as trust or behaviour, most individuals with ACEs followed restrictions and supported vaccination. Risks of negative outcomes in those exposed to ACEs are reduced through, for instance, exposure to sources of resilience.[17,36,37] Thus, access to a supportive adult, connectedness with local communities and support managing behaviour and emotions in childhood are all related to reducing risks of poor outcomes from ACEs across the life-course.[38–40] During the pandemic, available sources of resilience for children may have fallen and exposure to

ACEs risen in some communities;[41,42] harming children and potentially increasing future risks of poor life-course outcomes and rejection of virus control restrictions. Policies and interventions that prevent ACEs and build resilience are increasingly well evidenced and include better parenting support, legislation to protect children in the home and policies to reduce issues such alcohol misuse.[43,44] Whilst such interventions may not immediately impact adult views and support for pandemic restrictions, they may encourage trust and support for public services in children and in the longer-term increase community resilience to transmission of future infections.

There were a number of important limitations with this study. Compliance was 36.4% of those answering the telephone. Although this is similar to many phone surveys, including during COVID-19,[45,46] we do not have any measures of whether responses would have differed in those refusing to participate or not answering calls. The survey used self-reported measures of ACEs and COVID-19 related behaviour. Individuals may have either exaggerated, forgotten or chose not to disclose childhood adversities or compliance with COVID-19 restrictions. However, levels of ACEs reported were comparable to those previously collected in the UK including through face-to-face interviews.[33] Whilst the survey included a final sample of over 2,000 individuals, it did not provide adequate numbers for any detailed analyses by ethnicity, limiting analyses to just binary white and other categories. Whilst low level of ethnic minority participants reflects that Wales has only 5.6% of adults from Black, Asian and other minority ethnic groups,[47] this could be rectified in further studies with oversampling in such communities.

Conclusions

There is an immediate and on-going need to understand how best to maximise uptake of COVID-19 vaccinations and compliance with public health restrictions aimed at reducing the spread of COVID-19 or any other infectious agents that may provide a threat to public health. Coping with trauma resulting from at least one current or previous ACE is common in the populations of many countries with proportions having experienced multiple ACEs frequently reaching ten percent or more of the population.[7] Such individuals are already known to have greater health risks across the life-course. Results here, suggest such individuals may have more difficulty with compliance with public health control measures and consequently require additional support. A better understanding of how to increase their trust in health systems and compliance with health guidance is urgently required. Without

consideration of how best to engage such individuals, some risk being effectively excluded from population health interventions, remaining at higher risks of infection and posing a potential transmission risk to others. Increasing the appeal of public health information and interventions, such as vaccination, to those who have experienced ACEs should be considered in health protection responses. Longer term however, achieving better compliance with pandemic and other public health advice is another reason to invest in safe and secure childhoods for all children which are free from ACEs and rich in sources of resilience. Such measures appear likely not only to reduce health-harming behaviours and ill health across the life-course but may also reduce the spread of COVID-19 or other infectious threats to public health that may materialise in subsequent decades.

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Contributors

MAB and KH designed the study and all authors contributed to questionnaire development. HM, FG and KH contributed to the development of other survey materials and coordination with the Market Research Company. KF prepared the dataset for analysis and MAB undertook data analyses. MAB wrote the manuscript with contributions from KH and KF. All authors reviewed the study findings and read and approved the final version before submission. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted.

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Competing interests

None declared.

Patient consent

Not required.

Ethics approval

Ethical approval for the study was granted by the Bangor University Healthcare and Medical Sciences Ethics Committee (Ref 2020-16844). All interviews abided by the Market Research Society Code of Conduct.

Data sharing statement

The dataset analysed in the current study is available from the corresponding author on reasonable request.

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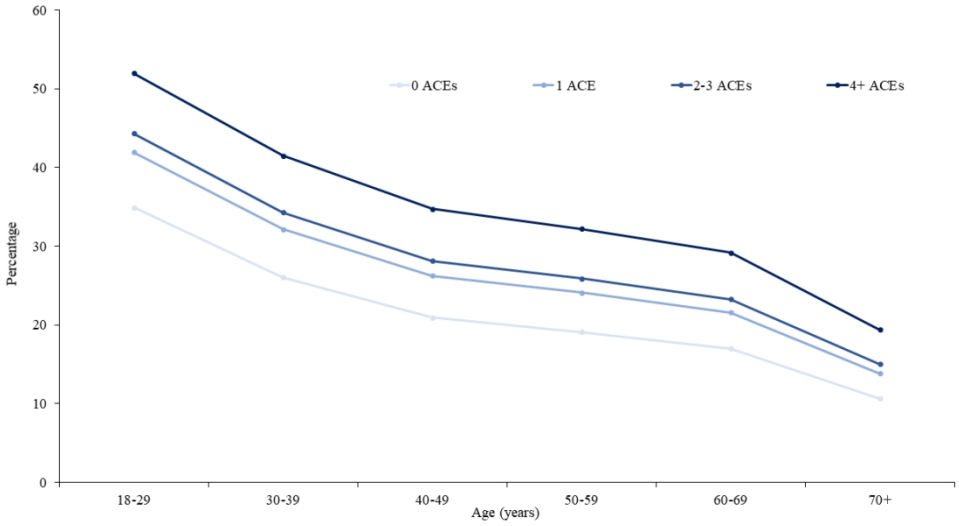

Figure 1 Adjusted mean percentage of individuals having broken COVID-19 restrictions at least occasionally, by age and adverse childhood experience (ACE) count

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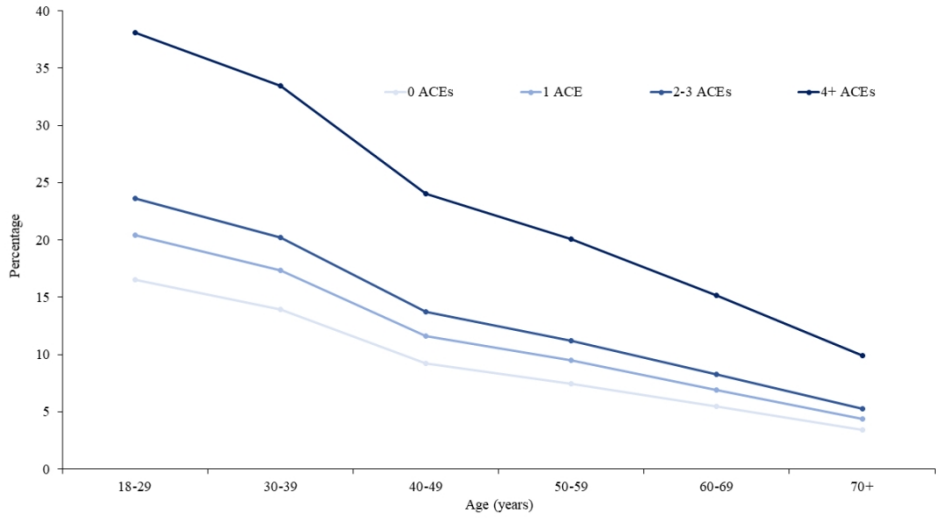

Figure 2 Adjusted mean percentage of individuals with vaccine hesitancy, by age and adverse childhood experience (ACE) count

855x481mm (38 x 38 DPI)

Appendix Table A1. Questions and qualifying responses for adverse childhood experiences (ACEs), COVID-19 and health variables

	Question ***(response options)***	**Qualifying response**
ACEs	All ACE questions were preceded by the statement "While you were growing up, before the age of 18..."	
Physical abuse	How often did a parent or adult in your home ever hit, beat, kick, or physically hurt you in any way? This does not include gentle smacking for punishment. *(never; once; more than once; prefer not to say)*	Once or more than once
Verbal abuse	How often did a parent or adult in your home ever swear at you, insult you, or put you down? *(never; once; more than once; prefer not to say)*	More than once
Sexual abuse	Did an adult or someone at least five years older than you sexually abuse you by touching you or making you undertake any sexual activity with them? *(yes; no; prefer not to say)*	Yes
Parental separation	Were your parents ever separated or divorced? *(yes; no; prefer not to say)*	Yes
Domestic violence	How often did your parents or adults in your home ever slap, hit, kick, punch, or beat each other up? *(never; once; more than once; prefer not to say)*	Once or more than once
Mental illness	Did you live with anyone who was depressed, mentally ill or suicidal? *(yes; no; prefer not to say)*	Yes
Alcohol abuse	Did you live with anyone who was a problem drinker or alcoholic? *(yes; no; prefer not to say)*	Yes
Drug abuse	Did you live with anyone who used illegal street drugs or abused prescription medications? *(yes; no; prefer not to say)*	Yes
Incarceration	Did you live with anyone who served time or was sentenced to serve time in a prison or young offenders' institution? *(yes; no; prefer not to say)*	Yes
COVID-19		
Low trust in NHS COVID-19 information	On a scale of 0 to 10 where 0 is not at all and 10 is completely, how much would you trust information about Coronavirus from the NHS? *(0-10)*	0 to 5
Unfairly restricted a lot by government	During the coronavirus pandemic do you feel you have been unfairly controlled by – the national restrictions imposed by the government? *(no; yes, a little; yes, a lot)*	Yes – a lot
Mandatory face coverings should go	Do you think that wearing face coverings in shops should continue to be a legal requirement? *(no; yes)*	No
Social distancing should end	Social distancing is currently set at 2 metres. Do you think social distancing should remain in place or be removed? *(remain in place; be removed)*	Be removed
Break restrictions at least occasionally	During lockdown or local restrictions have you….? *(always followed the advice; bent or broken the rules occasionally; largely ignored the rules)*	Occasionally bent or broken or ignored
Vaccine hesitancy	If you were offered a coronavirus vaccination, would you want to be vaccinated (*Yes; already been vaccinated; no; unsure*)?	No or unsure
Had COVID-19	Do you think you have had coronavirus? (or currently have it) *(yes; no; don't know)*	Yes
Health		
Chronic disease	Have you ever been told by a doctor or nurse that you have the following conditions, and if so, how old were you when you were first diagnosed? cancer, type 2 diabetes, heart disease (coronary heart disease, heart attack or stroke), or respiratory disease (chronic bronchitis, emphysema, chronic obstructive pulmonary disease, asthma) (*no; yes; prefer not to say*)	Yes to one or more

Appendix Table A2. Proportion within adverse childhood experience (ACE) count categories by participant characteristics

		n	0 ACEs	1 ACE	2-3 ACEs	4+ ACEs	X^2	P
	All	2285	51.86	21.40	16.46	10.28		
Age (years)	18-29	174	32.76	25.29	24.14	17.82		
	30-39	239	35.98	23.43	22.18	18.41		
	40-49	371	50.67	18.06	19.14	12.13		
	50-59	543	50.83	21.55	17.31	10.31		
	60-69	447	53.69	22.15	15.44	8.72		
	70+	511	66.14	20.74	9.20	3.91	125.204	<0.001
Deprivation quintile	Least 1	495	53.33	24.04	14.34	8.28		
	2	509	56.19	21.22	13.36	9.23		
	3	490	53.27	22.65	16.53	7.55		
	4	437	49.43	20.59	17.62	12.36		
	Most 5	354	44.63	17.23	22.32	15.82	41.746	<0.001
Sex	Male	806	52.48	21.46	17.49	8.56		
	Female	1479	51.52	21.37	15.89	11.22	4.509	0.212
Ethnicity	White	2254	52.04	21.43	16.37	10.16		
	Other	31	38.71	19.35	22.58	19.35	4.340	0.227
Had COVID-19[$]	No	1837	53.57	21.18	15.79	9.47		
	Yes	448	44.87	22.32	19.20	13.62	14.036	0.003
Chronic disease[£]	No	1488	52.22	21.44	16.60	9.74		
	Yes	797	51.19	21.33	16.19	11.29	1.371	0.712

[$]Having had COVID-19 was self-reported, see methods. [£]Chronic diseases included cancer, type II diabetes, heart disease and respiratory diseases, see methods for details. Full wording of all questions is provided in Appendix Table A1.

Appendix Table A3. Modelled estimates of means and confidence intervals for having broken COVID-19 restrictions at least occasionally (%) and vaccine hesitancy (%) by age and adverse childhood experience (ACE) count

		Break restrictions at least occasionally			Vaccine hesitancy		
Age (years)	ACE count	EMM	95% CIs Lower	Upper	EMM	95% CIs Lower	Upper
18-29	0	34.95	24.15	47.55	16.52	9.32	27.58
	1	41.94	29.77	55.17	20.39	11.53	33.46
	2-3	44.31	31.79	57.59	23.63	13.77	37.49
	4+	51.95	38.34	65.27	38.06	24.08	54.35
30-39	0	26.05	17.39	37.08	13.95	7.83	23.62
	1	32.13	21.85	44.49	17.34	9.68	29.11
	2-3	34.28	23.50	46.97	20.22	11.60	32.85
	4+	41.48	29.13	54.99	33.48	20.75	49.18
40-49	0	20.92	13.99	30.09	9.24	5.16	16.00
	1	26.24	17.61	37.18	11.64	6.28	20.57
	2-3	28.15	19.07	39.46	13.73	7.61	23.52
	4+	34.74	23.86	47.50	24.01	14.09	37.84
50-59	0	19.10	12.82	27.49	7.48	4.19	12.99
	1	24.10	16.24	34.21	9.47	5.14	16.79
	2-3	25.91	17.53	36.52	11.22	6.20	19.45
	4+	32.21	22.01	44.45	20.06	11.58	32.46
60-69	0	17.01	11.17	25.04	5.43	2.85	10.12
	1	21.60	14.21	31.41	6.92	3.51	13.20
	2-3	23.28	15.35	33.68	8.24	4.22	15.48
	4+	29.19	19.41	41.37	15.14	8.03	26.73
70+	0	10.67	6.72	16.53	3.42	1.66	6.93
	1	13.84	8.64	21.42	4.38	2.03	9.20
	2-3	15.03	9.33	23.33	5.25	2.43	10.96
	4+	19.38	12.02	29.73	9.91	4.68	19.77

CIs = Confidence Intervals; EMM = Estimated Marginal Mean.

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-5
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5-7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5-6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-7, Table A1
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6-7, Table A1
Bias	9	Describe any efforts to address potential sources of bias	5, 16
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6-7, Table A1
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7-8
		(*b*) Describe any methods used to examine subgroups and interactions	7-8
		(*c*) Explain how missing data were addressed	6
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	NA
		(*e*) Describe any sensitivity analyses	NA
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6
		(b) Give reasons for non-participation at each stage	NA
		(c) Consider use of a flow diagram	NA
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8, 10, Table A2
		(b) Indicate number of participants with missing data for each variable of interest	NA
Outcome data	15*	Report numbers of outcome events or summary measures	8

Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	10,11, Table A3
		(*b*) Report category boundaries when continuous variables were categorized	6-7, Table A1
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	13, Figures 1a & 1b, Table A3
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	8
Discussion			
Key results	18	Summarise key results with reference to study objectives	13-14
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	16
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	14-16
Generalisability	21	Discuss the generalisability (external validity) of the study results	16
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	17

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Associations between adverse childhood experiences, attitudes towards COVID-19 restrictions and vaccine hesitancy: a cross-sectional study

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Title	Associations between adverse childhood experiences, attitudes towards COVID-19 restrictions and vaccine hesitancy: a cross-sectional study
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Abstract

Objectives: Adverse childhood experiences (ACEs) can affect life-course health and well-being, including risk-taking behaviour and trust. This study explored associations between ACEs and trust in health information on COVID-19, attitudes towards and compliance with COVID-19 restrictions, and vaccine hesitancy.

Design: National cross-sectional telephone survey using a sample of landline and mobile numbers stratified by Health Board, deprivation quintile and age group.

Setting: Households in Wales during national COVID-19 restrictions (December 2020 to March 2021).

Participants: 2,285 Welsh residents aged ≥18 years.

Measures: Nine ACEs; low trust in national health service (NHS) COVID-19 information; supporting removal of social distancing and mandatory face coverings, breaking COVID-19 restrictions, and vaccine hesitancy (rejection or uncertainty of vaccination).

Results: Increasing ACE counts were independently related to low trust in NHS COVID-19 information, feeling unfairly restricted by government and ending mandatory face coverings. High ACE counts (≥4 vs. 0 ACEs) were also associated with supporting removal of social distancing. Breaking COVID-19 restrictions increased with ACE count with likelihood doubling from no ACEs to ≥4 ACEs. Vaccine hesitancy was threefold higher with ≥4 ACEs (vs. 0 ACEs) and higher in younger age groups. Thus, modelled estimates of vaccine hesitancy ranged from 3.42% with no ACEs, aged ≥70 years, to 51.85% with ≥4 ACEs, aged 18-29 years.

Conclusions: ACEs are common across populations of many countries. Understanding how they impact trust in health advice and uptake of medical interventions could play a critical role in the continuing response to COVID-19 and controlling future pandemics. Individuals with ACEs suffer greater health risks throughout life and may also be excluded from interventions that reduce infection risks. Whilst pandemic responses should consider how best to reach those suffering from ACEs, longer term, better compliance with public health advice is another reason to invest in safe and secure childhoods for all children.

Article summary

Strengths and limitations of this study

- A large national sample surveyed during a period of national COVID-19 restrictions.
- Although not unusual for unsolicited telephone surveys, the participation level was 36.4%, creating a potential for a self-selection bias among respondents.
- Prevalence of ACEs reported was consistent with other comparable population surveys, including those undertaken face to face.
- ACEs were self-reported and measured retrospectively and therefore may have been misremembered or otherwise misreported.
- Outcomes investigated both measures of trust and preference for different health regulations and restrictions as well as measures of behaviour.

INTRODUCTION

In many countries, the control of COVID-19 has relied on public acceptance of, and compliance with, restrictions on travel, work, socialising and public behaviour.[1] Medical advice provided through governmental and health professional bodies has formed the principal mechanism for encouraging social isolation, mask wearing and other COVID-19 prevention measures. Although restrictions are often reinforced with fines and other judicial measures, their implementation still depends heavily on public support.[2–4] Moreover, despite some discussion on mandatory vaccination, the success of this emergent COVID-19 control measure also relies on individuals having confidence in and complying with health messaging.[5] Consequently, it is critical for COVID-19 control to understand what factors differentiate individuals who may or may not trust health information, adhere to behavioural advice or accept offers of vaccination. Such understanding can inform the development and targeting of future measures to maximise behavioural compliance and vaccine uptake in different population groups.

Adverse childhood experiences (ACEs) include child maltreatment (physical, psychological, sexual and neglect) and other sources of chronic trauma in childhood, such as growing up in a household affected by domestic violence, substance use and other criminal justice problems.[6] Multiple studies have shown strong relationships between experiencing more types of ACEs and the development of health-harming behaviours such as smoking, harmful alcohol use and illicit drug use, as well as increased involvement in anti-social behaviour and violence.[7,8] Although suffering ACEs is not deterministic, higher exposure to ACEs is related to a greater likelihood of developing chronic health conditions such as cancer, cardiovascular disease, type 2 diabetes and respiratory diseases.[7,9–11] Thus, individuals with ACEs may be at greater risks of COVID-19 related morbidity and mortality through higher vulnerability resulting from behaviours such as smoking[12] and conditions such as obesity[13] and diabetes.[14] ACEs are also associated with substantive increases in poor mental health.[7,15] Moreover, more limited research suggests maltreatment during childhood may leave individuals with lower levels of trust including in health and other public services.[16,17] What is less well studied is whether a history of ACEs impacts compliance with advice and instruction from public health and health care systems. Around half of adults in Europe and North America have experienced at least one ACE with estimates suggesting around a quarter have suffered multiple ACEs.[18] Consequently, it is important to understand and address any impact of ACEs on compliance with COVID-19

controls in order to avoid repercussions both for the health of those with ACEs and for infection risks in their local communities.

Here, we examine relationships between a history of childhood adversity and current levels of trust in health systems information, support for and compliance with COVID-19 control restrictions, and intention to be COVID-19 vaccinated. We hypothesise that, independent of socio-demographics, exposure to more ACEs will be associated with less trust in health systems, lower support for governmental restrictions intended to control COVID-19 transmission and higher vaccination rejection rates (termed here vaccine hesitancy). We examine these relationships through a national anonymous telephone survey of adults in Wales. Finally, we explore how measures to influence public behaviour might better support those who have suffered ACEs with respect both to COVID-19 and preparing for other future pandemics.

METHODS

Data collection

A national telephone survey of Welsh residents aged 18 years and over was conducted between December 2020 and March 2021. Although pilot data were collected on 15th and 16th December, final survey data collection all occurred within a period of consistent national COVID-19 restrictions in Wales. Thus, a national lockdown including orders to stay at home and mandatory closure of non-essential retail, hospitality sectors and gyms was established 20th December 2020 with relaxation of restrictions beginning predominantly from 13th March 2021[19]. Mixing of two households indoors was permitted for just 25th December 2020 but no data collection occurred on this day. A minimum target sample of 2,000 was set to capture adequate individuals across ACE categories, with a minimum of 200 respondents in the highest ACEs category (4+).[17] A professional market research company (MRC) was commissioned to undertake sampling and data collection. Landline and mobile telephone contacts were obtained from a commercial sample provider stratified by Welsh Health Board area, residential deprivation quintile (using Welsh Index of Multiple Deprivation [WIMD][20]) and age group, to attain a sample broadly representative of the age, deprivation and geographical profile of the Welsh population.

Study inclusion criteria were Welsh resident aged 18 years or over and cognitive ability to participate in a telephone interview. Potential participants were given a verbal description of the study including its purpose and voluntary, anonymous and confidential nature. Participants were informed they could skip or decline questions, withdraw at any point and that a decision to stop would not affect their rights, health treatment or service provision. Informed consent was recorded using opt-in consent. A web address was provided to participants containing further study information and links to appropriate support services. All study materials were provided in English and Welsh and participants could complete the interview in either language. Telephone calls were made across all days of the week; between the hours of 9am-9pm on weekdays and 10am-4pm on weekends, and interviews took on average 20 minutes to complete.

Contact was made with 6,763 individuals, of whom 98 (1.4%) were ineligible, 4,062 (60.1%) declined and 2,603 agreed to participate in the study. Of those who agreed, 277 did not meet the age quota in their area and 2,326 completed the questionnaire, with 64.7% of respondents being female. Thus, the participation rate was 36.4% (2,326/6,388) of eligible individuals who met the quota sampling, or 34.9% (2,326/6,665) of all eligible participants. The sample used for analysis here was limited to participants who answered all questions of interest (N=2,285).

Study questionnaire

The study questionnaire included questions on participant demographics, ACEs, health conditions, trust in information on COVID-19 from the National Health Service (NHS), and attitudes towards COVID-19 restrictions and vaccination. All measures were self-reported. The full questions and response options used to measure ACEs and the outcomes included in this study are provided in Appendix Table A1.

Nine ACE types before the age of 18 years (physical, verbal and sexual abuse; parental separation; exposure to domestic violence; and living with a household member with mental illness, alcohol abuse, drug abuse or who was incarcerated) were measured using an adapted version of the Centers for Disease Control and Prevention short ACE tool.[21] In line with international literature,[7] responses to the nine ACE questions were used to calculate an ACE count (0 ACEs, 1 ACE, 2-3 ACEs, 4+ ACEs). Such categorisation has enabled: comparative examination of individuals exposed to lower, mid, and higher counts of ACEs; a

more consistent approach to analyses between ACE studies; and combined analyses of findings from different studies.[7] *Low trust in NHS COVID information* was measured by a question asking how much participants would trust information on COVID-19 from the NHS (scale 0=not at all, 10=completely; low <6). Feeling *unfairly restricted a lot by government* was identified by a response of 'yes, a lot' to a question asking if, during the pandemic, participants felt they had been unfairly controlled by the national restrictions imposed by the government. Beliefs that *mandatory face coverings should go* and *social distancing should end* were measured with questions asking if face coverings in shops should continue to be a legal requirement (qualifying response 'no') and if social distancing should remain in place or be removed (qualifying response 'be removed') respectively. Participants were asked if, during lockdown or local COVID-19 restrictions, they had always followed the advice, bent or broken the rules occasionally, or largely ignored the rules; those providing either of the latter two responses were categorised as *break restrictions at least occasionally*. *Vaccine hesitancy* was identified by responses of 'no' or 'unsure' to a question asking if participants would want to receive a COVID-19 vaccination. Participants were categorised as having *had COVID-19* if they responded 'yes' to a question asking if they thought they have had, or currently have, coronavirus; and as having had a *chronic disease* if they reported having ever been told by a doctor or nurse that they had any of the following conditions: cancer, type 2 diabetes, heart disease (coronary heart disease, heart attack or stroke), or respiratory disease (chronic bronchitis, emphysema, chronic obstructive pulmonary disease, asthma).

Sex (male; female; other), ethnicity (self-defined using UK census categories) and postcode of residence were also collected. For the purposes of anonymity and consistent with previous studies, respondents' age was collected in five-year age groups but combined into 10-year age categories (18-29, 30-39, 40-49, 50-59, 60-69, 70+) in order to ensure sufficient numbers in each category for analysis. Due to low levels in non-white categories, ethnicity was re-categorised (white, other). Postcode was categorised into deprivation quintile by the MRC using the WIMD (1=least deprived to 5=most deprived).

Statistical analysis

Statistical analyses used SPSS v27. Cross-tabulations and chi-square tests were used to measure relationships between outcome variables, and to examine initial relationships between outcome variables and ACEs and other participant characteristics (age, sex, ethnicity, deprivation, COVID-19 infection and chronic disease). Independent associations

between ACEs and outcomes were measured using logistic regression, controlling for other participant demographics. Having had COVID-19 was included in the model as it was hypothesised that individuals who report this may feel protected from the virus.[22] Similarly suffering from a chronic disease was included in the model as individuals with a chronic disease may feel more at risk of the virus. Finally, the estimated adjusted proportions (estimated marginal means; EMMs) reporting breaking restrictions at least occasionally and vaccine hesitancy in different ACE categories and age groups were generated from the final logistic regression models.

Patient and public involvement

The study did not involve patients. Study findings are being made publicly available to participants and the general public through the production of study reports and open access journal articles. The study webpages provided contact details for the research team if any individual wished to directly request publications.

RESULTS

Approximately half of participants reported having experienced no ACEs (51.86%) with proportions in the 1 ACE, 2-3 ACEs and 4+ ACE categories being 21.40%, 16.46% and 10.28% respectively. A breakdown of participant demographics by ACE count is shown in Appendix Table A2. Respondents' views of having low trust in NHS COVID-19 information and being unfairly restricted a lot by government were associated with higher levels of favouring the immediate cessation of social distancing and mandatory face coverings, breaking restrictions, and vaccine hesitancy (Table 1). For example, 42.11% of those reporting low trust in NHS COVID-19 information also reported vaccine hesitancy, compared with just 5.62% of those without such low trust.

Table 1. Relationships between views on fairness of restrictions, trust in NHS COVID-19 information and support for COVID-19 control and vaccination measures

		Low trust in NHS COVID-19 information (%)	Unfairly restricted a lot by government (%)	Social distancing should end (%)	Mandatory face coverings should go (%)	Break restrictions at least occasionally (%)	Vaccine hesitancy (%)
All (n=2,285)		5.82	9.41	5.91	5.82	25.86	7.75
Low trust in NHS COVID-19 information	No		7.81	4.51	4.32	24.86	5.62
	Yes		35.34	28.57	30.08	42.11	42.11
	X^2		111.387	130.480	151.552	19.426	233.296
	P		<0.001	<0.001	<0.001	<0.001	<0.001
Unfairly restricted a lot by government	No*	4.15		3.91	3.77	24.40	5.80
	Yes	21.86		25.12	25.58	40.00	26.51
	X^2	111.387		157.517	169.061	24.732	116.950
	P	<0.001		<0.001	<0.001	<0.001	<0.001

NHS = National Health Service. *Includes those who responded 'yes, a little'. See Appendix Table A1 for full wording of all questions and classification of responses.

Low trust in NHS COVID-19 information

Individuals with higher ACE counts were more likely to have low trust in NHS COVID-19 information along with individuals from more deprived quintiles of residence (Table 2). Other socio-demographics and a history of either chronic disease or COVID-19 infection were not significantly associated with low trust. When using logistic regression to control for confounding relationships, ACEs and deprivation were the only significant predictors of trust in NHS COVID-19 information (Table 3).

Unfairly restricted a lot by government

Just under one in 10 people reported feeling unfairly restricted (Table 1). This rose with ACE count, with the proportion among those with four or more ACEs being more than twice as high as in those with none (Table 2). Younger individuals were also more likely to report feeling unfairly restricted, along with those who were resident in more deprived quintiles and those who reported having had COVID-19 (Table 2). When using logistic regression, independent relationships between feeling unfairly restricted and increasing ACE count remained, although differences between the no ACE and one ACE categories failed to reach significance. Logistic regression showed younger age and being male were also significantly related to feeling unfairly restricted (Table 3).

Social distancing should end

Supporting the removal of social distancing increased more than threefold from those with no ACEs to those with four or more (Table 2). Ending social distancing was also significantly more supported by those who were younger and male. Ethnicity, deprivation, or having had COVID-19 or a chronic disease were not significantly associated with support for ending social distancing. Using logistic regression, having more ACEs was still significantly associated with favouring ending social distancing but only having four or more ACEs remained significantly different from no ACEs (Table 3). Those aged 60 years or over were significantly less likely to support ending social distancing (compared with those aged 18-29 years) with males also substantially more likely than females to support social distancing ending (Table 3).

Table 2. Adverse childhood experiences (ACEs), socio-demographics, other individual characteristics and associations with compliance with, trust in and support for COVID-19 control measures

		n	Low trust in NHS COVID-19 information (%)	Unfairly restricted a lot by government (%)	Social distancing should end (%)	Mandatory face coverings should go (%)	Break restrictions at least occasionally (%)	Vaccine hesitancy (%)
ACE count	0	1,185	4.05	7.26	4.39	3.46	20.93	4.98
	1	489	5.73	8.59	5.73	6.34	28.02	7.16
	2-3	376	7.45	12.23	5.59	7.45	31.12	10.11
	4+	235	12.34	17.45	14.47	14.04	37.87	19.15
	X^2		26.817	28.154	35.999	43.081	39.321	58.625
	P		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Age (years)	18-29	174	6.90	16.09	10.92	9.77	47.70	18.39
	30-39	239	7.11	12.97	9.21	12.97	35.98	15.90
	40-49	371	6.20	10.78	9.16	8.89	28.84	9.16
	50-59	543	5.16	9.21	6.45	5.16	26.34	7.00
	60-69	447	4.70	7.83	3.13	3.36	23.04	4.70
	70+	511	6.26	6.07	2.15	1.76	13.50	2.74
	X^2		2.839	21.525	39.054	54.389	100.389	75.027
	P		0.725	0.001	<0.001	<0.001	<0.001	<0.001
Deprivation quintile	Least 1	495	4.44	9.29	4.65	4.24	26.67	4.44
	2	509	3.73	5.70	4.13	4.32	26.13	5.50
	3	490	5.10	8.16	6.33	5.51	28.37	7.76
	4	437	8.70	11.67	7.55	6.86	25.63	9.84
	Most 5	354	8.19	13.84	7.63	9.32	21.19	12.99
	X^2		16.440	19.909	8.485	13.207	5.838	27.466
	P		0.002	0.001	0.075	0.010	0.212	<0.001
Sex	Male	806	6.95	10.67	7.69	8.06	27.79	8.56
	Female	1479	5.21	8.72	4.94	4.60	24.81	7.30
	X^2		2.887	2.322	7.131	11.438	2.412	1.156
	P		0.089	0.128	0.008	0.001	0.120	0.282
Ethnicity	White	2,254	5.77	9.36	5.90	5.81	25.87	7.59
	Other	31	9.68	12.90	6.45	6.45	25.81	19.35
	X^2		0.853	0.450	0.017	0.023	0.000	5.926
	P		0.356	0.502	0.897	0.880	0.994	0.015
Had COVID-19[$]	No	1,837	5.50	8.49	5.50	5.39	24.39	6.80
	Yes	448	7.14	13.17	7.59	7.59	31.92	11.61
	X^2		1.777	9.245	2.833	3.180	10.656	11.625
	P		0.182	0.002	0.092	0.075	0.001	0.001
Chronic disease[£]	No	1,488	5.51	9.68	6.45	7.06	29.50	8.40
	Yes	797	6.40	8.91	4.89	3.51	19.07	6.52
	X^2		0.747	0.360	2.267	11.887	29.452	2.556

P	0.387	0.548	0.132	0.001	<0.001	0.110

ACE = adverse childhood experience. [$]Having had COVID-19 was self-reported, see methods. [£]Chronic diseases included cancer, type II diabetes, heart disease and respiratory diseases, see methods for details. Full wording of all questions is provided in Appendix Table A1.

Table 3. Logistic regression analysis of relationships between adverse childhood experiences (ACEs), socio-demographics and other individual characteristics and compliance with, trust in and support for COVID-19 control measures

		Low trust in NHS COVID-19 information			Unfairly restricted a lot by government			Social distancing should end			Mandatory face coverings should go			Break restrictions at least occasionally			Vaccine hesitancy		
		AOR	95%CIs	P	AOR	95%CIs	P	AOR	95%CIs	P	AOR	95%CIs	P	AOR	95%CIs	P	AOR	95%CIs	P
ACE count	0	Ref		<0.001	Ref		0.002	Ref		<0.001	Ref		<0.001	Ref		<0.001	Ref		<0.001
	1	1.46	0.90-2.37	0.123	1.13	0.76-1.67	0.549	1.22	0.76-1.98	0.410	1.80	1.10-2.94	0.019	1.34	1.05-1.73	0.020	1.29	0.83-2.02	0.254
	2-3	1.82	1.11-2.99	0.017	1.50	1.02-2.21	0.042	1.01	0.60-1.72	0.963	1.76	1.06-2.93	0.029	1.48	1.13-1.94	0.004	1.56	1.01-2.43	0.047
	4+	3.22	1.94-5.36	<0.001	2.19	1.44-3.33	<0.001	2.89	1.79-4.68	<0.001	3.57	2.14-5.94	<0.001	2.01	1.47-2.76	<0.001	3.11	2.00-4.82	<0.001
Age (years)	18-29	Ref		0.819	Ref		0.112	Ref		<0.001	Ref		<0.001	Ref		<0.001	Ref		<0.001
	30-39	1.05	0.48-2.30	0.897	0.78	0.44-1.37	0.378	0.88	0.45-1.71	0.706	1.51	0.79-2.88	0.214	0.66	0.44-0.98	0.041	0.82	0.48-1.40	0.465
	40-49	1.08	0.52-2.24	0.847	0.71	0.41-1.20	0.198	0.96	0.52-1.77	0.900	1.13	0.60-2.14	0.702	0.49	0.34-0.72	<0.001	0.51	0.30-0.88	0.015
	50-59	0.92	0.45-1.88	0.819	0.63	0.38-1.05	0.074	0.67	0.37-1.23	0.197	0.67	0.35-1.27	0.219	0.44	0.31-0.63	<0.001	0.41	0.24-0.69	0.001
	60-69	0.89	0.42-1.89	0.753	0.55	0.32-0.96	0.034	0.32	0.15-0.66	0.002	0.46	0.22-0.96	0.038	0.38	0.26-0.56	<0.001	0.29	0.16-0.53	<0.001
	70+	1.29	0.62-2.69	0.495	0.45	0.25-0.79	0.006	0.23	0.10-0.50	<0.001	0.27	0.11-0.64	0.003	0.22	0.15-0.34	<0.001	0.18	0.09-0.36	<0.001
Deprivation quintile	Least 1	Ref		0.024	Ref		0.012	Ref		0.275	Ref		0.157	Ref		0.031	Ref		0.010
	2	0.82	0.43-1.53	0.527	0.59	0.36-0.96	0.034	0.87	0.47-1.61	0.664	1.04	0.56-1.94	0.903	1.01	0.75-1.34	0.970	1.30	0.73-2.34	0.375
	3	1.14	0.63-2.06	0.666	0.84	0.54-1.32	0.451	1.36	0.77-2.39	0.285	1.28	0.71-2.34	0.413	1.07	0.80-1.43	0.631	1.76	1.01-3.05	0.046
	4	1.87	1.08-3.24	0.026	1.19	0.77-1.82	0.433	1.54	0.88-2.71	0.131	1.56	0.86-2.81	0.143	0.89	0.66-1.21	0.468	2.09	1.21-3.61	0.008
	Most 5	1.64	0.91-2.95	0.100	1.33	0.85-2.07	0.209	1.36	0.75-2.46	0.318	1.91	1.06-3.45	0.033	0.64	0.45-0.89	0.009	2.44	1.41-4.23	0.001
Sex*	Male	1.42	0.99-2.04	0.059	1.35	1.01-1.82	0.044	1.89	1.32-2.72	0.001	2.29	1.59-3.31	<0.001	1.28	1.05-1.57	0.016	1.37	0.99-1.91	0.060
Ethnicity*	Other	1.44	0.42-4.93	0.559	1.00	0.34-2.94	1.000	0.70	0.16-3.00	0.626	0.63	0.14-2.73	0.534	0.70	0.30-1.61	0.395	1.78	0.69-4.56	0.230
Had COVID-19*,$	Yes	1.18	0.77-1.81	0.443	1.37	0.99-1.91	0.058	1.07	0.71-1.63	0.745	1.04	0.66-1.55	0.949	1.22	0.96-1.54	0.104	1.33	0.93-1.90	0.121
Chronic disease*,£	Yes	1.07	0.73-1.58	0.722	0.99	0.72-1.36	0.958	0.92	0.61-1.38	0.691	0.55	0.35-0.87	0.010	0.68	0.54-0.85	0.001	0.94	0.65-1.35	0.731

AOR = adjusted odds ratio; 95%CIs = 95% confidence intervals; Ref = reference category. $Having had COVID-19 was self-reported, see methods. £Chronic diseases included cancer, type II diabetes, heart disease and respiratory diseases, see methods for details. *Reference categories for sex, ethnicity, Had COVID-19 and chronic disease were female, white, not had COVID-19 and not had a chronic disease respectively. Full wording of all questions is provided in Appendix Table A1.

Mandatory face coverings should go

Support for ending mandatory face coverings increased more than fourfold between those with no ACEs and those with four or more ACEs (Table 2). Younger individuals, those resident in more deprived quintiles, males and those who had not had a chronic disease were more likely to support mandatory face coverings ending. In logistic regression, ACE counts continued to show a positive relationship with support for ending mandatory face coverings. This was significant even with a single ACE compared to those with no ACEs (Table 3). Younger ages, being male and not having had a chronic disease remained significantly associated with ending mandatory face covering measures. However, differences by age were only significant between the 18-29 years and 60+ years groups (Table 3).

Break restrictions at least occasionally

Overall, around one in four respondents broke COVID-19 restrictions at least occasionally (Table 1). In bivariate analyses, proportions having broken restrictions increased with ACE count and decreased with age but were not significantly related to deprivation, sex or ethnicity. Those who reported having already had COVID-19 and those without a history of chronic disease were more likely to have broken restrictions (Table 2). When controlling for relationships between variables, breaking restrictions remained strongly related to ACE count with the likelihood of such behaviours being twice as high in those with four or more ACEs compared to those with none (Table 3). Breaking restrictions also remained significantly associated with younger ages and not having suffered from a chronic disease, with deprivation also marginally significant (with less restriction breaking in the most deprived quintile; Table 3).

Vaccine hesitancy

Around one in 13 individuals surveyed reported vaccine hesitancy (Table 1). However, this increased around fourfold between those with no ACEs and those with four or more (Table 2). Younger age groups were also more likely to report vaccine hesitancy along with those living in more deprived quintiles, those of other than white ethnicity and those who had already had COVID-19 (Table 2). Applying logistic regression, having more ACEs remained significantly associated with vaccine hesitancy, although the difference between the no ACEs and one ACE category was not significant. Younger age remained strongly related to vaccine hesitancy along with being resident in more deprived quintiles. Ethnicity was not

significantly related to vaccine hesitancy once ACEs, age and deprivation had been accounted for (Table 3).

For breaking restrictions and vaccine hesitancy we also generated estimated levels (EMMs) in order to provide absolute measures of prevalence of breaking restrictions and vaccine hesitancy by ACE and age categories (Figures 1 & 2). For having broken restrictions at least occasionally, estimated levels ranged from 10.67% (95% confidence intervals [95%CIs], 6.72%-16.53%) in those aged 70+ years with no ACEs to 51.95% (95%CIs 38.34%-65.27%) in those aged 18-29 years with four or more ACEs (Figure 1). Similarly for vaccine hesitancy, levels ranged from 3.42% (95%CIs 1.66%-6.93%, no ACEs, aged 70+ years) to 38.06% (95%CIs 24.08%-54.35%, 4+ ACEs, aged 18-29 years; Figure 2). Within any single age group, ACE count contributed to a steep increase in predicted breaking of restrictions and vaccine hesitancy. For instance, for vaccine hesitancy, in those aged 30-39 years, there was a rise from 13.95% (95%CIs 7.83%-23.62%) in those with no ACEs to 33.48% (95%CIs 20.75%-49.18%) in those with four or more (Figure 2). Confidence intervals for all data points are provided in Appendix Table A3.

Figure 1 Adjusted mean percentage of individuals having broken COVID-19 restrictions at least occasionally, by age and adverse childhood experience (ACE) count

Figure 2 Adjusted mean percentage of individuals with vaccine hesitancy, by age and adverse childhood experience (ACE) count

(Insert Figures 1 and 2 here)

DISCUSSION

Voluntary compliance with public health advice has played a central role in reducing the viral transmission of COVID-19. In this study, approximately a quarter of participants admitted to at least occasionally breaking the rules (Table 1) while a minority supported immediately ending social distancing and face coverings (5.91% and 5.82% respectively; Table 1); regulations in place at the time of this study.[19] Critically, 7.75% of individuals would not immediately agree to a COVID-19 vaccination. Vaccine hesitancy, as well as breaking or ending current restrictions, were related to socio-demographics with younger age groups in particular reporting more restriction breaking and higher vaccine hesitancy (Table 2, Figures

1 & 2). As reported elsewhere, males were also more likely to break restrictions and favour an end to those in place (Table 3).[3,23] Lower trust in NHS COVID-19 information and feeling unfairly restricted by government were also related to vaccine hesitancy and restriction breaking (Table 1). However, whilst interrelations between trust in public bodies and compliance with guidance has been studied elsewhere,[2,24] far less attention has paid to the life-course factors that may contribute to lower trust in health and state systems and potential rejection of related regulations and medical interventions.

Critically, most individuals surveyed, including those with ACEs, supported and followed COVID-19 restrictions (Table 2, Figure 1). However, results identify individuals with a history of childhood adversity having less trust in NHS COVID-19 information and being more likely to favour removal of control measures (Tables 2 and 3). Lower trust in NHS COVID-19 information tripled between those with no ACEs and those with four or more and feeling unfairly restricted by government more than doubled (Table 2). Such increases are consistent with other findings here that individuals with four or more ACEs were two times more likely to break restrictions at least occasionally compared to those with no ACEs when controlling for relationships with socio-demographic factors and history of COVID-19 infection or chronic disease (Table 3). Studies elsewhere suggest individuals with ACEs are more likely to have developmental and behavioural factors that increase the risk of ill health across the life-course;[25] potentially leaving them more susceptible to infection and ill health from COVID-19 (e.g. through smoking, cancer[7,12,26]). Consequently, understanding why individuals with ACEs may be more likely to reject virus control measures is vital to protecting their health.

A number of outcomes previously associated with exposure to ACEs may contribute to links between greater ACE exposure and lower compliance with and support for COVID-19 interventions. Higher ACEs are associated with lower acceptance of delayed gratification with greater preference for short term returns at the expense of potentially greater return in the longer term.[27,28] ACEs have also been associated with lower prosocial behaviours and sense of belonging,[17,29] although such effects are not well studied in adults, nor whether they affect consideration of how personal behaviour may impact the well-being of others in local communities. However, a history of ACEs is known to be associated with other anti-social behaviours, including violence.[7] Higher exposure to ACEs is also associated with poorer mental well-being and alcohol and drug use[18] with the latter especially having

known associations with the adoption of wider risk-related behaviours.[30,31] Finally, ACEs have been associated with having lower trust both in other individuals and public services,[16,17,32] a finding consistent with results here whereby lower trust in COVID-19 information from the NHS increased from 4.05% with no ACE to 12.34% in those with four or more (Table 2).

With vaccination at the centre of COVID-19 control strategies going forward, higher levels of vaccine hesitancy in those with more ACEs is an important consideration. In those aged 18-29 years, modelled vaccine hesitancy more than doubled from an estimated 16.52% in those with no ACEs to 38.06% in those with four or more (Figure 1, Appendix Table A3). In this study 48.14% of individuals had at least one ACE and 10.28% had four or more. Such figures are consistent with those reported in other studies (e.g. England,[33] USA,[9] New Zealand[34]) suggesting that ACEs are a feature of the life-course of a substantive proportion of the population. Consequently, unaddressed high levels of vaccine hesitancy in this group represent a significant risk to the health of those with a history of ACEs and potentially also to those in their local communities. Our results suggest that ACE- and trauma-informed approaches may be an important consideration when considering compliance with infection control restrictions and in improving uptake of medical interventions such as COVID-19 vaccination. Although little work has been undertaken specific to COVID-19, increased compliance from those with ACEs may benefit from a greater emphasis on safety and trustworthiness. Thus, strategies may consider use of alternative spaces and settings, avoiding ones which may potentially be associated with previous negative experiences for some individuals (e.g. health care). They may also require different channels for information provision to account for lower trust in public services. Moreover, awareness and training for those contacting individuals, potentially with a history of trauma, may allow them to support those still wavering, for instance, with vaccine compliance.[35]

Consistent with exposure to ACEs not being deterministic of outcomes such as trust or behaviour, most individuals with ACEs followed restrictions and supported vaccination. Risks of negative outcomes in those exposed to ACEs are reduced through, for instance, exposure to sources of resilience.[17,36,37] Thus, access to a supportive adult, connectedness with local communities and support managing behaviour and emotions in childhood are all related to reducing risks of poor outcomes from ACEs across the life-course.[38–40] During the pandemic, available sources of resilience for children may have fallen and exposure to

ACEs risen in some communities;[41,42] harming children and potentially increasing future risks of poor life-course outcomes and rejection of virus control restrictions. Policies and interventions that prevent ACEs and build resilience are increasingly well evidenced and include better parenting support, legislation to protect children in the home and policies to reduce issues such alcohol misuse.[43,44] Whilst such interventions may not immediately impact adult views and support for pandemic restrictions, they may encourage trust and support for public services in children and in the longer term increase community resilience to transmission of future infections.

There were a number of important limitations with this study. Compliance was 36.4% of those answering the telephone. Although this is similar to many phone surveys, including during COVID-19,[45,46] we do not have any measures of whether responses would have differed in those refusing to participate or not answering calls. The survey used self-reported measures of ACEs and COVID-19 related behaviour. Individuals may have either exaggerated, forgotten or chose not to disclose childhood adversities or compliance with COVID-19 restrictions. However, levels of ACEs reported were comparable to those previously collected in the UK including through face-to-face interviews.[33] Whilst the survey included over 2,000 individuals, women were overrepresented in the final sample. However, sufficient data were available to include sex in all data models in order to identify differences between sexes and to control for sex-related differences when examining relationships between outcomes of interest and other independent variables. The sample did not provide adequate numbers for detailed analyses by individual ethnicity types, limiting analyses to just binary white and other categories. However, even with a low sample size and all black, Asian and other minority groups combined into a single category, odds of vaccine hesitancy, for instance, were substantially higher than in the white population (1.78, 95%CIs 0.69-4.56); although this failed to reach statistical significance (Table 3). Whilst the low level of ethnic minority participants reflects Wales having only 5.6% of adults from black, Asian and other minority ethnic groups,[47] this could be rectified in further studies with oversampling in such communities and may result in the identification of other important differences between ethnicities. Analysis employed a categorical approach to variables including ACE count and age. Whilst this allowed non-ordinal comparisons between categories, potential differences between individuals within categories may have been obscured. Finally, while the survey was conducted during a period of national lockdown, individuals' responses may have been affected by the timing of their interview (e.g. near the

start or end of the lockdown period). However, individuals from all different socio-demographic groups were sampled throughout the entire data collection period.

Conclusions

There is an immediate and on-going need to understand how best to maximise uptake of COVID-19 vaccinations and compliance with public health restrictions aimed at reducing the spread of COVID-19 or any other infectious agents that may provide a threat to public health. Coping with trauma resulting from at least one current or previous ACE is common in the populations of many countries with proportions having experienced multiple ACEs frequently reaching ten percent or more of the population.[7] Such individuals are already known to have greater health risks across the life-course. Results here, suggest such individuals may have more difficulty with compliance with public health control measures and consequently require additional support. A better understanding of how to increase their trust in health systems and compliance with health guidance is urgently required. Without consideration of how best to engage such individuals, some risk being effectively excluded from population health interventions, remaining at higher risks of infection and posing a potential transmission risk to others. Increasing the appeal of public health information and interventions, such as vaccination, to those who have experienced ACEs should be considered in health protection responses. Longer term however, achieving better compliance with pandemic and other public health advice is another reason to invest in safe and secure childhoods for all children which are free from ACEs and rich in sources of resilience. Such measures appear likely not only to reduce health-harming behaviours and ill health across the life-course but may also reduce the spread of COVID-19 or other infectious threats to public health that may materialise in subsequent decades.

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Contributors

MAB and KH designed the study and all authors contributed to questionnaire development. HM, FG and KH contributed to the development of other survey materials and coordination with the Market Research Company. KF prepared the dataset for analysis and MAB

undertook data analyses. MAB wrote the manuscript with contributions from KH, KF and SW. All authors reviewed the study findings and read and approved the final version before submission. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted.

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Competing interests

None declared.

Patient consent

Not required.

Ethics approval

Ethical approval for the study was granted by the Bangor University Healthcare and Medical Sciences Ethics Committee (Ref 2020-16844). All interviews abided by the Market Research Society Code of Conduct.

Data sharing statement

The dataset analysed in the current study is available from the corresponding author on reasonable request.

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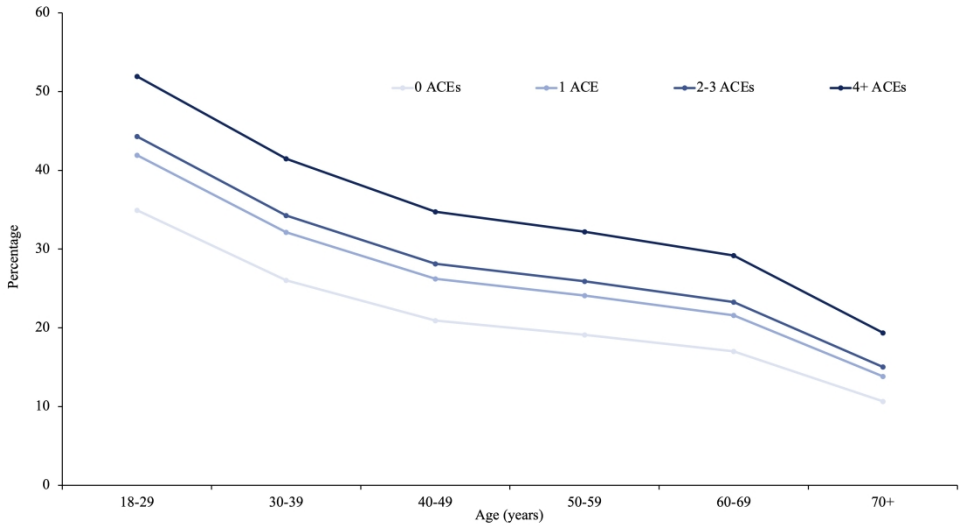

Figure 1 Adjusted mean percentage of individuals having broken COVID-19 restrictions at least occasionally, by age and adverse childhood experience (ACE) count

1646x926mm (72 x 72 DPI)

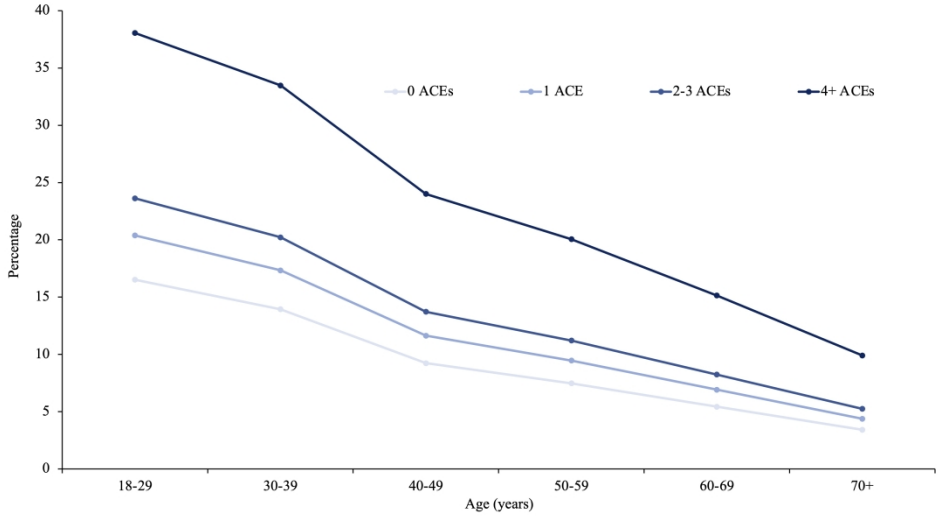

Figure 2 Adjusted mean percentage of individuals with vaccine hesitancy, by age and adverse childhood experience (ACE) count

1646x926mm (72 x 72 DPI)

Appendix Table A1. Questions and qualifying responses for adverse childhood experiences (ACEs), COVID-19 and health variables

	Question ***(response options)***	**Qualifying response**
ACEs	All ACE questions were preceded by the statement "While you were growing up, before the age of 18..."	
Physical abuse	How often did a parent or adult in your home ever hit, beat, kick, or physically hurt you in any way? This does not include gentle smacking for punishment. *(never; once; more than once; prefer not to say)*	Once or more than once
Verbal abuse	How often did a parent or adult in your home ever swear at you, insult you, or put you down? *(never; once; more than once; prefer not to say)*	More than once
Sexual abuse	Did an adult or someone at least five years older than you sexually abuse you by touching you or making you undertake any sexual activity with them? *(yes; no; prefer not to say)*	Yes
Parental separation	Were your parents ever separated or divorced? *(yes; no; prefer not to say)*	Yes
Domestic violence	How often did your parents or adults in your home ever slap, hit, kick, punch, or beat each other up? *(never; once; more than once; prefer not to say)*	Once or more than once
Mental illness	Did you live with anyone who was depressed, mentally ill or suicidal? *(yes; no; prefer not to say)*	Yes
Alcohol abuse	Did you live with anyone who was a problem drinker or alcoholic? *(yes; no; prefer not to say)*	Yes
Drug abuse	Did you live with anyone who used illegal street drugs or abused prescription medications? *(yes; no; prefer not to say)*	Yes
Incarceration	Did you live with anyone who served time or was sentenced to serve time in a prison or young offenders' institution? *(yes; no; prefer not to say)*	Yes
COVID-19		
Low trust in NHS COVID-19 information	On a scale of 0 to 10 where 0 is not at all and 10 is completely, how much would you trust information about Coronavirus from the NHS? *(0-10)*	0 to 5
Unfairly restricted a lot by government	During the coronavirus pandemic do you feel you have been unfairly controlled by – the national restrictions imposed by the government? *(no; yes, a little; yes, a lot)*	Yes – a lot
Mandatory face coverings should go	Do you think that wearing face coverings in shops should continue to be a legal requirement? *(no; yes)*	No
Social distancing should end	Social distancing is currently set at 2 metres. Do you think social distancing should remain in place or be removed? *(remain in place; be removed)*	Be removed
Break restrictions at least occasionally	During lockdown or local restrictions have you….? *(always followed the advice; bent or broken the rules occasionally; largely ignored the rules)*	Occasionally bent or broken or ignored
Vaccine hesitancy	If you were offered a coronavirus vaccination, would you want to be vaccinated (*Yes; already been vaccinated; no; unsure*)?	No or unsure
Had COVID-19	Do you think you have had coronavirus? (or currently have it) *(yes; no; don't know)*	Yes
Health		
Chronic disease	Have you ever been told by a doctor or nurse that you have the following conditions, and if so, how old were you when you were first diagnosed? cancer, type 2 diabetes, heart disease (coronary heart disease, heart attack or stroke), or respiratory disease (chronic bronchitis, emphysema, chronic obstructive pulmonary disease, asthma) (*no; yes; prefer not to say*)	Yes to one or more

Appendix Table A2. Proportion within adverse childhood experience (ACE) count categories by participant characteristics

		n	0 ACEs	1 ACE	2-3 ACEs	4+ ACEs	X^2	P
	All	2285	51.86	21.40	16.46	10.28		
Age (years)	18-29	174	32.76	25.29	24.14	17.82		
	30-39	239	35.98	23.43	22.18	18.41		
	40-49	371	50.67	18.06	19.14	12.13		
	50-59	543	50.83	21.55	17.31	10.31		
	60-69	447	53.69	22.15	15.44	8.72		
	70+	511	66.14	20.74	9.20	3.91	125.204	<0.001
Deprivation quintile	Least 1	495	53.33	24.04	14.34	8.28		
	2	509	56.19	21.22	13.36	9.23		
	3	490	53.27	22.65	16.53	7.55		
	4	437	49.43	20.59	17.62	12.36		
	Most 5	354	44.63	17.23	22.32	15.82	41.746	<0.001
Sex	Male	806	52.48	21.46	17.49	8.56		
	Female	1479	51.52	21.37	15.89	11.22	4.509	0.212
Ethnicity	White	2254	52.04	21.43	16.37	10.16		
	Other	31	38.71	19.35	22.58	19.35	4.340	0.227
Had COVID-19[$]	No	1837	53.57	21.18	15.79	9.47		
	Yes	448	44.87	22.32	19.20	13.62	14.036	0.003
Chronic disease[£]	No	1488	52.22	21.44	16.60	9.74		
	Yes	797	51.19	21.33	16.19	11.29	1.371	0.712

[$]Having had COVID-19 was self-reported, see methods. [£]Chronic diseases included cancer, type II diabetes, heart disease and respiratory diseases, see methods for details. Full wording of all questions is provided in Appendix Table A1.

Appendix Table A3. Modelled estimates of means and confidence intervals for having broken COVID-19 restrictions at least occasionally (%) and vaccine hesitancy (%) by age and adverse childhood experience (ACE) count

		Break restrictions at least occasionally			Vaccine hesitancy		
Age (years)	ACE count	EMM	95% CIs Lower	Upper	EMM	95% CIs Lower	Upper
18-29	0	34.95	24.15	47.55	16.52	9.32	27.58
	1	41.94	29.77	55.17	20.39	11.53	33.46
	2-3	44.31	31.79	57.59	23.63	13.77	37.49
	4+	51.95	38.34	65.27	38.06	24.08	54.35
30-39	0	26.05	17.39	37.08	13.95	7.83	23.62
	1	32.13	21.85	44.49	17.34	9.68	29.11
	2-3	34.28	23.50	46.97	20.22	11.60	32.85
	4+	41.48	29.13	54.99	33.48	20.75	49.18
40-49	0	20.92	13.99	30.09	9.24	5.16	16.00
	1	26.24	17.61	37.18	11.64	6.28	20.57
	2-3	28.15	19.07	39.46	13.73	7.61	23.52
	4+	34.74	23.86	47.50	24.01	14.09	37.84
50-59	0	19.10	12.82	27.49	7.48	4.19	12.99
	1	24.10	16.24	34.21	9.47	5.14	16.79
	2-3	25.91	17.53	36.52	11.22	6.20	19.45
	4+	32.21	22.01	44.45	20.06	11.58	32.46
60-69	0	17.01	11.17	25.04	5.43	2.85	10.12
	1	21.60	14.21	31.41	6.92	3.51	13.20
	2-3	23.28	15.35	33.68	8.24	4.22	15.48
	4+	29.19	19.41	41.37	15.14	8.03	26.73
70+	0	10.67	6.72	16.53	3.42	1.66	6.93
	1	13.84	8.64	21.42	4.38	2.03	9.20
	2-3	15.03	9.33	23.33	5.25	2.43	10.96
	4+	19.38	12.02	29.73	9.91	4.68	19.77

CIs = Confidence Intervals; EMM = Estimated Marginal Mean.

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-5
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5-7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5-6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-7, Table A1
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6-7, Table A1
Bias	9	Describe any efforts to address potential sources of bias	5, 16
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6-7, Table A1
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7-8
		(*b*) Describe any methods used to examine subgroups and interactions	7-8
		(*c*) Explain how missing data were addressed	6
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	NA
		(*e*) Describe any sensitivity analyses	NA
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6
		(b) Give reasons for non-participation at each stage	NA
		(c) Consider use of a flow diagram	NA
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8, 10, Table A2
		(b) Indicate number of participants with missing data for each variable of interest	NA
Outcome data	15*	Report numbers of outcome events or summary measures	8

Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	10,11, Table A3
		(*b*) Report category boundaries when continuous variables were categorized	6-7, Table A1
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	13, Figures 1a & 1b, Table A3
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	8
Discussion			
Key results	18	Summarise key results with reference to study objectives	13-14
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	16
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	14-16
Generalisability	21	Discuss the generalisability (external validity) of the study results	16
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	17

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.